

The Construction, Reconstruction and Deconstruction of Shruti

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Introduction

Intonation, and in particular the concept of shruti (*sruti*), has perhaps received more scholarly attention than any other research topic in Indian art music. After the *Natya-sastra*, the first work to extensively discuss shruti, virtually all treatises on music have elaborated, criticized or commented upon this issue. Shruti is intimately linked to the fundamental concept of *svara*. Whereas *svara* is a musical note or scale degree, of which there are seven, shruti is a more subtle division of the octave. From early times, an octave was said to contain 22 shrutis, and as we shall see, the relation between shruti and *svara* has been a major source of confusion. It has not been uncommon to refer to shrutis as microtones or quarter tones, but with 22 shrutis to divide over seven *svaras* in an octave, this clearly presents a mathematical problem¹. Almost two centuries later, in spite of intensive research and heated debate, the issue has not been fully resolved.

Up to the time of Ahobala, the first scholar in India (in the second half of the seventeenth century) to deal with pitch in terms of string lengths, most of the discussions about micro-intervals have been ambiguous, for want of exact pitch measurements.² The famous experiment with the two *vinas* (*vina*), in which Bharata demonstrates the 22 shrutis, is based exclusively on hearing. Even when an actual analysis was attempted, especially by some of the theoreticians of the nineteenth and twentieth centuries, it was usually aimed at supporting the theory of musical scales as propounded by the ancient Sanskrit authors. Although the awareness of a discrepancy between the ancient theory and contemporary practice had been growing at least from Ramamatya's time (1550), it was only in the second half of the twentieth century that theories of intonation based on empirical research emerged.³ Nonetheless, a comprehensive model of contemporary intonation practice has yet to be developed. Empirical research generally goes just far enough to ascertain that the Sanskrit theories cannot be applied to present-day music, an allegation that still meets with much emotional resistance from both and musicologists.

¹ In a paper by S. M. Tagore there is an extensive discussion about the propriety of using the term quarter tone. See Tagore 1875: 354-58.

² Pandithar 1917: 378. The author gives the precise measurements in a tabular form. It should also be noted that Sarngadeva (thirteenth century) had already described the position of the frets on the *vina*, thus enabling us to get some notion of the intervals used.

³ See for instance Jairazbhoy and Stone 1963, Levy 1982, Bel and Arnold 1983, Rao 1990, Meer 2000.

This paper traces the historical development of the concept of shruti. A special attempt has been made to review developments during the last two centuries in the context of the cultural renaissance that emerged in response to colonial rule. In addition, an account is provided of recent research based on the actual analysis of music.

The Construction of Shruti

Ancient Period

The term shruti is derived from the Sanskrit root *sru*, to hear. Hence, shruti literally means that which is heard. In Sanskrit literature, this applies to all works which are considered to have been revealed by divine force. It applies therefore to the Mantra and Brahmana portions of the Vedas and also to the Upanishads.⁴

In musicology shruti has a more specific meaning and the discussion of shruti is invariably associated with Bharata's *Natya-sastra*, a work on theatre dating approximately from the second century AD.⁵ It is to be noted that in the *Natya-sastra* we do not find a clear definition of shruti. This may suggest that the term had already been established before Bharata's time. In the *Naradiya-siksha*, parts of which are older than the *Natya-sastra*, five types of shrutis are enumerated, implying that shruti must originally have referred to variations of the Samavedic notes.⁶ There are grounds to assume that this variation had more to do with timbre or tonal quality than with pitch.⁷ In this work, an important observation is made about the vexing nature of shrutis: "As foot-marks of fish and birds do not remain in water and sky, similarly the shrutis are known by their timbre (*dhvanivisesa*) and not by their size".⁸

Yet it is in the monumental treatise of Bharata, that the theory of shruti is fully expanded. In chapter six he first mentions the seven musical notes – *sadja*, *risabha*, *gandhara*, *madhyama*, *panchama*, *dhaivata* and *nisada* (often referred to as Sa, Re, Ga, Ma, Pa, Dha, Ni respectively).⁹ In chapter 20, the term shruti is mentioned in connection with musical scales (*grama*).¹⁰ Significantly, Bharata discusses shruti in connection with instrumental music. He

⁴ Garret 1987: 607.

⁵ Although the *Natya-sastra*, attributed to the sage Bharata, is quoted many times in almost all subsequent works, it was first recovered in full around the 1860s.

⁶ *Natya-sastra* 1/7/9-15.

⁷ Rowell 1998: 82-3.

⁸ Ranade 2000: 37.

⁹ *Natya-sastra*, chapter VI: 27-29.

¹⁰ Ibid: chapter XX: 5.

lists shruti as one of the capabilities of the vina while refraining from mentioning it in relation to the human voice.¹¹

Bharata used the unit of shruti to define the interrelation of two notes in terms of consonance and dissonance. He considers two notes to be *samvadi* (consonant) if there are 9 or 13 shrutis between them, intervals which have invariably been equated with the perfect fourth and fifth. If the interval is of 2 or 20 shrutis, on the other hand, the notes are considered *vivadi* or dissonant. Notes are termed as *anuvadi* or assonant (neither consonant nor dissonant) if they have any other interval sizes between them.¹² After stating that there are 22 shrutis in each scale (*grama*), Bharata gives the following arrangement for the *sadja-grama* and *madhyama-grama*.

<i>sadja-grama:</i>	Sa	3	Re	2	Ga	4	Ma	4	Pa	3	Dha	2	Ni	4	Sa
<i>madhyama-grama:</i>	Sa	3	Re	2	Ga	4	Ma	3	Pa	4	Dha	2	Ni	4	Sa

Thus, a change of only one shruti is needed to make the two *grama* identical.¹³ As observed by S.A.K. Durga, Bharata seems to have followed the methodology of Sankhya philosophy in his treatment of shrutis and svaras.¹⁴ Without bringing in mathematical formulations, Bharata validates his theory of 22 shrutis (within an octave), taking the ear as the sole judge for his experiment.¹⁵

Widdess however makes a very strong case for a much more fundamental difference between the two *grama*. He suggests that in Bharata's time the *ma-grama* started from Ma and therefore represented a fundamentally different scale type. He suggests that the distinction between the two *grama* became irrelevant with the introduction of *murcchana* and *jati*.¹⁶

Medieval Period

¹¹ Ibid: 28/15.

¹² Ibid: 28/22-23.

¹³ Ibid: 28/24.

¹⁴ The Sankhya system which is based on systematic reasoning is one of the six philosophical schools of India, that flourished at the beginning of the Christian era. See Williams 1976: 36, 142 and 674; Durga 1991: 30.

¹⁵ The experiment involves two identical vinas. At first, both the vinas are tuned to the *sadja-grama* scale. Then, one is changed to the *madhyama-grama* scale by lowering the Pa by one shruti. Once more, when it is lowered by one shruti, Ga and Ni of this altered vina match the Re and Dha of the unaltered vina, thus demonstrating that Ga and Ni each consist of two shrutis. After the third lowering, Re and Dha match with the original Sa and Pa, indicating that Re and Dha each have three shrutis. The fourth lowering in a similar manner proves that Sa, Ma and Pa each have four shrutis. Thus a total of 22 is reached for an octave.

¹⁶ Widdess 1995: 209.

Following in Bharata's footsteps, his successors Matanga (c.800) and King Nanyadeva (r. 1097-1154) have reiterated the theory of 22 shrutis.¹⁷ However, it seems that by Matanga's time confusion and diverging views concerning shruti had already developed among scholars. Matanga sums up no less than five interpretations of the relation between shruti and svara. It is highly significant that he arrives at the conclusion that svara is manifested through the shrutis, and that svaras are separated from each other by bands of shrutis. As Rowell has pointed out, "this is in striking contrast to early Western musical thought, in which pitches were traditionally conceived as points".¹⁸

Most Western scholars who tried to unravel the question of the relation between the seven svaras and 22 shrutis have tried to look at shrutis as discrete tuning positions, thus adding to the discrepancy between theory and practice. That this interpretation is rather one-sided becomes clear from Abhinavagupta's commentary on the *Natya-sastra*, where shruti appears in the context of ornamentation, with the aim of heightening the emotional impact of a song. In addition he indicates that shrutis have a time value, which would obviously be impossible if it were only a tuning position.¹⁹ In fact Bharata also explains that the three-shruti interval on the flute should always be played with finger-vibrato.²⁰

Sarngadeva, author of the thirteenth-century *Sangita-ratnakara* describes shruti as a just-recognizable difference in pitch. In their commentaries on the *Sangita-ratnakara*, Simhabhupala and Kallinatha refer to Abhinavagupta, the great philosopher of the tenth century, describing shruti as "that sound which is heard soon after a chord is struck, while svara is that which persists thereafter".²¹ According to Sarngadeva as interpreted by Kallinatha, "shruti signifies a pitch value which contributes to the musicality of tone and is yet devoid of tonal colour".²² Whereas Simhabhupala remarks that: "... while establishing notes by appropriate positioning of frets on the vina, the *vainikas* do not think of number of shrutis, they rather play by the ear".²³ Sarngadeva gives separate names to each of the 22 shrutis, classifying them in five groups following Narada. Based on the concept of shruti as the smallest recognizable difference in pitch, Sarngadeva introduces the idea of natural (*suddha*) and modified (*vikrita*) notes. He states that there are 12 *vikrita* -positions of the svaras. While Sarngadeva discusses minute shifts of one or two shrutis in one section of his

¹⁷ However, as observed by Ranade, Nanyadeva was the first one to refer to new intervals, viz. *kaisiki-gandhar* and *kaisiki-nisad*, later mentioned by Sarngadeva in *Sangita-ratnakara*. See Ranade 2000: 83.

¹⁸ Rowell 1998: 151.

¹⁹ Ramanathan 1980: 103-4.

²⁰ Widdess 1995: 209.

²¹ Sarngadeva 1991: 118.

²² Sarngadeva 1991: 407.

²³ Desai 1979: 290.

work, as noted by Jairazbhoy, he makes no further reference to them in his following discussion on ragas.²⁴

Sometime during the fourteenth and fifteenth centuries, there was a new development relating to the tonal arrangement, which had a fundamental influence on music-making as well as theorizing. Possibly the most striking change was the fixing of the drone.²⁵ There is a clear indication to this effect in *Rasakaumudi* of Srikantha, “sadjā is the graha (initial note) of all ragas” (I-83).²⁶ Once the position of *shadjā* or Sa, the first note, was established as the immovable take-off point, the existing *murchhana* system of modulation was transformed into the immutable scale types of the ragas. Whereas in the old system it was possible to use each of the seven notes of the basic scale (*grāma*) as the tonic, now the tonic was fixed and all modulated scales were transposed to it.

The *Ghunyāt-ul-Munya* (1374-75) provides information about the medieval notion of 22 shrutis and their division over 12 note positions. It is interesting to note that according to the author, 21 shrutis are seen on the frets of the *bin* and the very same note which is produced from an open string is recognized as the twenty-second shruti. He also observes that the intervals are *mutasawī*, i.e. absolutely equal.²⁷

Post-Medieval Period

Continuing the process initiated by Vidyaranyaśwami (d. 1386), Ramamatya (1550) constructed a system of 16 *mela* and 64 ragas in his *Svara-mela-kalanidhi*. While still maintaining the system of 22 shrutis, he opposed Sarngadeva’s idea of 19 svaras. Instead, he proposed a system of 14 svaras (seven natural and seven *vikrīta* arising from the natural ones through the change of shrutis).²⁸ Such differences of opinion were bound to arise, since at no point in the history of shruti was it clarified by exact measurements.

In Somanatha’s *Raga-vibodha* (c.1609) one finds roots of some of the terms related to intonation, which are used even today in Hindustani music. For instance, *tivra*, *tivratar* and others are used to denote pitches with progressively higher shrutis, that is, raised by one

²⁴ Jairazbhoy 1958: 57. In the *Sāngitopaniśad-saroddhara* (1350), the 22 shrutis are named differently than in *Sāngita-ratnakara*. See Desai 1979: 287. The same trend is also observed later on in the fifteenth century in *Sāngita-damodara* of Shubhankara. See Shubhankara 1960: IV.

²⁵ We find no reference to this effect by Sarngadeva. However, his principal commentators Simhabhūpala and Kallinātha discuss this aspect, though not without a certain ambiguity. See Desai 1979: 190, 298.

²⁶ As cited in Sharma 2000: 316.

²⁷ Ghunyāt ul-Munya 1978: vii

²⁸ Desai 1979: 311.

shruti.²⁹ Although largely a follower of the *Sangita-ratnakara*, some of Somanatha's statements indicate that this was yet another exercise of rearranging the svara positions within the unquestionable authority of the system of 22 shrutis.³⁰

In his *Caturdandi-prakasika*, Venkatamakhi (1620) developed a system of 72 *mela*, which would remain in use till the present day in Karnatak (Carnatic) music. He recognized shruti as a special inseparable attribute of sound.³¹ Further, like his predecessors, he too could not resist proposing yet another subjective system of 12 notes (seven natural and five chromatic) fixed on the 22-shruti scale.

The considerable changes that took place in Indian music in the centuries after Sarngadeva are reflected in Ahobala's *Sangita-parijata* (c.1665). He still mentions the 22 shrutis as a theoretical construction that describes the laws of consonance within an octave, but he also suggests the existence of innumerable shrutis on account of minute pitch differences.³² Further, the author clarifies that only upon manifestation (in performance) do these shrutis qualify to be known as svaras; until such time, they are recognized only as shrutis.³³ It is emphasized that variance related to shrutis attaining the status of a svara has a definite aesthetic significance.³⁴ As stated before, Ahobala is the first author to discuss the position of the svaras in terms of string lengths, in which he basically establishes a system of 12 semitones.³⁵ Although the explicit formulation of a system of 12 semitones is therefore apparently a late development (and often associated with Muslim influence), Widdess has shown that the division of the octave into intervals of 2, 3 and 4 shrutis possibly became obsolete as early as the sixth century.³⁶

Contemporaries of Ahobala, notably Hridayanarayana and Srinivasa, further elaborate on the idea of relating pitch to mathematical formulations of interval ratios, in terms of the division

²⁹ Ibid: 327. In contemporary Hindustani terminology, *chadhi* (higher) and *utari* (lower) refer to the use of especially augmented or diminished pitches of notes such as *gandhara* in raga Darbari and raga Todi.

³⁰ Desai 1979: 329.

³¹ Venkatmakhi 1934: II/2-3. At present, in the Karnatak system the term shruti when used in singular form, refers to the drone of the *tanpura*, with which the voice or the instrument must be consonant.

³² Ahobala 1879: verse 40-41.

³³ Ahobala 1971: verse 39.

³⁴ Ibid: verse 50-59.

³⁵ As pointed out by Emmy Te Nijenhuis (1974: 28), it is not certain whether Ahobala or Hridayanarayanadeva invented the new temperament, and which of these two musicologists was the first to change the names of the notes. Nevertheless the new system is clearly described in Hridayanarayanadeva's *Hridayaparakasa* as well as in Ahobala's *Sangita-parijata*. Both these authors give accurate measurements for the division of the strings in order to determine the position of twelve notes in the octave, and thus enables us to calculate the exact frequency ratios of these notes.

³⁶ Widdess 1995: 222, 244.

of a vibrating string.³⁷ It is very clear from seventeenth-century treatises that theoreticians struggled hard to reconcile the revered theory of 22 shrutis with the 12-semitone system actually in use at that time. While maintaining the importance of fourths and fifths as a fundament to construct scales, they attempt to show how shrutis were alterations of each of the 12 semitones. The change from a modulation-based scale system to independent scale types with a fixed drone is reflected in the emergence of a system of 11 *that*. First mentioned by Hridayanarayana (c.1667) and later on adapted by Locana Kavi in his *Raga-tarangini* (c.1675), this system was adopted by Bhatkhande in the early twentieth century as a basis for classifying ragas.

Lochana gives several terms still used in present-day Hindustani music. For example, when Re and Dha lose one shruti each, they are to be termed as *komal*, while Ga and Ni, when raised by one and two shrutis, are to be identified as *tivra* and *tivratar* respectively.³⁸ Further, in proposing the system of 11 *that* for raga classification, Lochana mentions the use of *tivra* Ma, two shrutis higher than the normal Ma, for *that* such as Yaman and Dhanashri. Similarly, his statement that the note Dha used in raga Kafi should be recognized as *suddha* while the Dha of one shruti higher should be used in ragas like Puriya, indicates his efforts to distinguish ragas on the basis of shrutis, and also throws some light on the performing practice of the time.³⁹

At the end of the seventeenth century, Bhavabhatta in his *Anupa-sangita-ratnakara*, following Sarngadeva and Ahobala to a large extent, also attempted to propose svara positions for 20 *mela* on the basis of shrutis.⁴⁰

It is curious that these shruti positions do not seem to correspond in any way to the ragas as we know them today. This also largely holds true for the work *Sangit-sar* commissioned by Maharaja Pratap Singh of Jaipur (r. 1779-1803), in which a new terminology is used to denote alterations of scale degrees. In fact, even Willard's study on musical practice, written a few decades later, contains issues that are difficult to interpret today. This suggests that Indian music has undergone considerable changes in a period of even less than two centuries.

³⁷ Bhatkhande recounts this procedure in detail. See Bhatkhande 1940: 22-35. For more on tunings of Ahobala and Hridayanarayana, see Levy 1982: 19-20.

³⁸ Note that the fundamental scale of Ahobala and Lochana had a minor third and seventh, much like the fundamental scale of Bharata. Also see Desai 1979: 371. Although the basic *suddha* (natural) scale of Ahobala apparently resembles the present-day scale of Kafi (with Ga and Ni as flat notes), some of his dictates relating to svara positions seem to correspond to the present Hindustani system in which the *suddha* notes form a diatonic major scale. For example, Sa and Pa are immovable, Ma cannot be lowered, Re Ga, Dha and Ni can be lowered.

³⁹ In the early twentieth century V.D. Paluskar also maintained that the position of Dha in raga Puriya should be between the flat and natural Dha. See Paluskar 1914: 21.

⁴⁰ Desai 1979: 414.

The Reconstruction of Shruti

In Sanskrit literature on music it is hard to make a distinction between theory and practice. We do not really know to what extent shruti was a purely theoretical concept, nor how and when theory and practice diverged. It is only during the past two centuries or so, with Willard's work as a landmark heralding a new Indian musicology, that such a distinction has actually been made in musicological literature. The battle between the shruti pundits probably reached its zenith in the early twentieth century, when the discrepancies between theory and practice became most apparent.

Late Eighteenth Century

By the end of the eighteenth century, the British had established themselves throughout the country, bringing to an end the era of the mighty Mughal Empire. British paramountcy was established in 1818. Whilst the colonial rulers were busy gaining political and economic control over the subcontinent, British scholars, referred to as orientalist today, discovered a curious cultural conglomeration presented in the Indian subcontinent. They made great efforts to study Indian languages, especially Sanskrit. Although their pursuits seemed highly intellectual in nature, various recent scholars have pointed out that there was an underlying motive: the orientalist had taken upon themselves the "noble" task of discovering and reconstructing the pristine Hindu past, free from Muslim influence. In the same way, they showed a preference for the "dead" music discussed in the Sanskrit treatises rather than trying to understand and appreciate the current traditions, which naturally bore ineradicable influences from Muslim interactions.⁴¹

In his well-known paper *On the Musical Modes of the Hindus* (1792), William Jones was the first to draw the attention of European musicologists to the wealth of Sanskrit texts on the theory of Indian music and the antiquity of the raga system.⁴² Although there was some discussion relating to Indo-Persian texts on music, the very title of the paper clearly reflects a Hindu bias, making obvious Jones' veneration for India's Hindu past.

⁴¹ As Farrell points out: "That Indian music was ancient, with its own complex grammar and structure, scholars did not doubt; but they felt that the true 'Hindu' music tradition had been lost in obscurity. The performance practices that did exist were considered to be mere manifestations of an art corrupted by Muhammadan influences. That a distinctive Indo-Islamic style of music had developed in India by the late eighteenth century was apparently of little interest to the early scholars. It was not congruent with their search for antiquity". See Farrell 1997: 21.

⁴² Bor 1988: 55.

Intonation, as discussed in the Sanskrit treatises, received a great deal of attention from William Jones.⁴³ In a letter to Charles Wilkins, one of the society's earliest scholars, he writes that:

... a little tract called "the prosody of music" (from a book called *Sangheit Derpen*) enabled me yesterday to discover that the Hindu scale '*saregamapadany*' consists of two tetra chords exactly equal, and differing only in the sixth and seventh notes from our major scales – I find, also, that the Indians have not only semitones but even an enharmonic kind of thirds and fourths of notes.⁴⁴

In 1786, in collaboration with the Asiatic Society of Bengal, an Indian and a British musician, Jiwan Shah and Francis Fowke, worked together in Benares, testing the pitches of the *bin* against those of the harpsichord.⁴⁵ Jones also reports on another experiment carried out with a Hindu "lutanist" and a German violinist. **[quote from p. 142]⁴⁶ Joep to add**

Nineteenth Century

In the beginning of the nineteenth century, the elements of curiosity and dismay so far associated with Indian music made way for more serious and detailed studies. In one such study, J.D. Paterson proposed an interpretation of the 22-shruti system that was to have a lasting impact on the discussion of intonation in Indian music. He equated the *chatusruti* interval (four shrutis) with the major whole tone, the *trissruti* interval (three shrutis) with the minor whole tone and the *dvisruti* interval (two shrutis) with the major semitone. Since a diatonic just scale has three major whole tones, two minor whole tones and two major semitones, the total within an octave would be 22 shrutis.⁴⁷

Though this solution is elegant, it has the logical corollary that a single shruti can have many different values: $204 / 4 = 51$ cents, $182 / 3 = 61$ cents, $112 / 2 = 56$ cents, $204 - 182 = 22$ cents. Given the fact that Bharata's experiment with the two vinas was done by ear, the difference between 61, 56 and 51 cents may not have been so relevant, while the shruti of 22 cents may well have been his *pramana* shruti. Equating the shruti system with European just intonation led to an approach to the concept of shruti as a minute measurement of tuning distances, which would later prove to be incongruous with the musicians' view of shruti.⁴⁸

⁴³ Jones 1962: 140-42.

⁴⁴ Cannon 1970: 647.

⁴⁵ Fowke 1979: 250-54.

⁴⁶ Jones 1979: 70.

⁴⁷ Paterson 1807?, *passim*. The idea that the 22 shruti system may have been used to discriminate between the major whole tone and the minor whole tone had been made even before by Ouseley around 1800: 169.

⁴⁸ See The Deconstruction of Shruti and Conclusion

Another interesting problem to arise from this interpretation is that when the 13-shruti interval is equated with the perfect fifth it logically follows that the Pythagorean comma of 24 cents is equal to two shrutis ($12 \text{ fifths} = 13 \text{ shrutis} \times 12 = 156 \text{ shrutis} - \text{seven octaves} = 7 \times 22 \text{ shrutis} = 154 \text{ shrutis}$).⁴⁹

It was a captain in the army, N. Augustus Willard, who took it upon himself to write the first study on Indian music based on the performance practice of his time. It is highly significant that his work was almost totally disregarded after it appeared. Evidently, the only accepted way of looking at Indian music was the orientalist construct of the Hindu past. The real music of the “subaltern” was simply not an issue.⁵⁰ As the subject of intonation is only discussed in passing we do not dwell further on Willard’s contribution.⁵¹ However, it is important to indicate that his work was a product of a historical period in which European interest in “oriental” culture lived one of its best moments.

The strengthening of the grip of the British on the Indian subcontinent resulted soon afterwards in resistance, with the “Mutiny” of 1857 as a turning point. After the “Mutiny” the British attitude to Indian culture changed radically, leaving hardly any space for unbiased investigation. Persian had been replaced by English as the official language and already in 1835, T.B. Macaulay realized his ideal of creating a class of “intermediaries, Indian by race but British by culture”.⁵² It was among this class that Western scientific methods found a fertile soil.

Music, as a national symbol of native Indian culture, received much attention, on the one hand for political purposes and on the other for scholarly investigations by musicologists, Western as well as Indian. As observed by Farrell: “As the British tightened their economic and political grip on India, their interest in Indian music also changed. Indian music was no longer just a picturesque curiosity, but rather, another facet of Indian culture that had to be controlled and subjected to the rigours of scientific inquiry”.⁵³ In the quest for a new nationalism, music was singled out as the most Indian of the aspects of national life. The trend set by Jones and Willard was closely followed by Indian scholars such as Sorindro Mohun Tagore (1840-1914), who preferred to speak about “Hindu” music rather than Indian or Hindustani music.

⁴⁹ Yet another interpretation of the shruti system takes this anomaly as its foundation: Abdul Karim Khan and Kapileshwari 1968: 96.

⁵⁰ We may paraphrase Gayatri Spivak’s question by asking “Can the subaltern sing?” See Spivak 1988: 271, 308.

⁵¹ For more information on Willard, see Bor 1988: 58-59.

⁵² Macaulay 1835.

⁵³ Farrell 1997: 44.

Tagore himself was a rather ambiguous figure in Indian musicology. Nurtured in a transplanted atmosphere of European culture, he was a selfless champion of “Hindu” music, but at the same time, through works such as the *Victoria-Gitika* written in Sanskrit, he showed a strong allegiance to the British crown. Tagore was also at the centre of a debate on the nature of shrutis and their representation in notation. With the typical disparaging attitude of a colonial officer, Charles Baron Clark, the inspector of schools in Bengal, declared that staff notation would be the best medium for instructing music, calling Tagore’s Bengali notation “crude”.⁵⁴ Further controversies raged on the subject fuelled by the differing opinions expressed by a compatriot, Krishnadhan Banerjee. This made it very clear that the issue of representation of music with all its microtonal subtleties was of great concern to musicologists, both Indian and Western. So much so that during the First All-India Music Conference at Baroda (1916) the subject of introducing a suitable notation system for the Indian music was addressed by none other than V.D. Paluskar.⁵⁵

The harmonium, introduced into the Indian music scene around 1850, would provide new fuel for a heated debate on the nature of the shrutis. It was ironic that while the nationalists propagated a revival of pure “Hindu” music, an imported keyboard instrument with a tempered scale was welcomed with open arms by both professional and amateur singers as a suitable accompaniment to the voice.⁵⁶ Interestingly, the losing fight against the harmonium was spearheaded by influential Indians such as Rabindranath Tagore, and Europeans such as violinist Maud McCarthy.⁵⁷ It should be pointed out that equal temperament had become widespread in European music precisely because of the industrial production of instruments like the harpsichord, pianoforte, accordion and harmonium.⁵⁸ Even in this period, a number of European musicians and musicologists were opposed to equal temperament, searching for the purity of harmonic intervals in “oriental” culture. The mission of establishing links with

⁵⁴ For more details on the notation system adopted by Tagore, refer to Capwell [in the present volume](#).

⁵⁵ Powers describes Paluskar as “one of a tiny handful of people in British India who were responsible for bringing classical music safely from the nineteenth century world of princely courts and artistic secrets into a twentieth century urban world of concert-going connoisseurs and music lessons for middle class amateurs” See Powers 1980: 24. He also brands Paluskar as an active nationalist who sang the national song “*Vande Mataram*” at every session of the Indian National Congress from 1915 onwards. Ibid: 26. Incidentally, the song was a creation of well-known genius-novelist from Bengal, Bankimchandra Chatterjee (1838-1894). According to Michael Kinnear, the foundation of an Indian sound recording industry began in 1900 with Hemendra Mohan Bose, a Bengali businessman and a convinced nationalist, who succeeded in taking a cylinder recording of this popular poem, meaning “Hail to the Mother” rendered by the famous poet, painter, musician and Nobel laureate, Rabindranath Tagore. First released in 1906, it was immensely popular with the record-buying public at the time. See Bor and Miner [in the present volume](#).

⁵⁶ In the late 1930s, at the initiative of the English composer John Foulds and with the support of the first controller of Broadcasting, Lionel Fielden, and music authorities such as S. N. Ratanjankar, the harmonium was banned from the national broadcasting network. However, its popularity with the musicians at large could not be stopped. See Bor [in the present volume](#).

⁵⁷ See Bor and Miner [in this volume: Indian music: The Modern Period](#).

⁵⁸ Goodall 2000: 143.

India's pristine past set in motion by the orientalists assumed rigour through notation and theories relating to intonation.

Amongst Western musicologists, the question of tuning systems was still very much debated. It should be remembered that Helmholtz' authoritative work on acoustics was published only in 1863 and translated into English in 1875 (by Alexander Ellis)⁵⁹, and that equal temperament became the standard only in the course of the nineteenth century. Up to that time there was a minute difference in pitch between C sharp and D flat, and many musicologists felt that equal temperament was undesirable. For Indian scholars, shrutis provided evidence for the existence of complex mathematical acoustics in ancient India and a nearly superhuman pitch discrimination and control on the part of the performers, although there was no substantial evidence to support either of these claims.⁶⁰ As a result, the subject of shruti continued to dominate the writings of the late nineteenth and early twentieth centuries. The volume of literature produced on this subject is so full of contradictions and rhetoric that it has made the issue even more abstruse than before. Moreover, the literature continues to refer mainly to the music and musical treatises of the past, largely disregarding the practice of contemporary musicians, who in their turn, for a long time remained blissfully unaffected by the musings of the theorists.

Yet late nineteenth century writings on music do provide some interesting insights by musicians, music educators and musicologists into the subject of intonation. Balkrishnabuwa Ichalkaranjekar (1883), for example, a Maharashtrian Brahmin and torchbearer of the Gwalior tradition, says: "There are some aspects in sangitshastra that are although comprehensible, difficult to experience today".⁶¹ In this context he has elaborated on two issues, viz., 22 shruti and the experience of *rasa*. He lamented that the knowledge and skill required for bringing about an appropriate *rasa* through proper deployment of shruti was becoming rare among musicians and hence, at present it was not common to encounter such an experience.⁶²

Similarly, Krishnadhan Banerjee, in his *Gita Sutra Sar* states:

In Indian music no scientific rule has yet been framed as to how much raising or lowering will sharpen or flatten a tone. The ustads sing these *vikrit*-accidentals by raising or lowering the tones according to their own practice, taste and training.⁶³

⁵⁹ Ellis is considered to be one of the first musicologists who empirically studied differences between important musical systems world wide (Ellis 1884, 1885).

⁶⁰ Powers 1980: 98.

⁶¹ Ichalkaranjekar (no date) :27.

⁶² Ibid: 28.

⁶³ Banerjee 1941: 9.

In this work, the complex topic of intonation seems to have been complicated further with the usage of the term *murchhana*. Instead of its original meaning (usually translated as mode), the term seems to have been used among musicians to convey a specific inflection or ornamentation associated with the articulation and intonation of a note.⁶⁴ At the same time, the author of *Gita Sutra Sar* considers this a misuse of the term by some Indian and European scholars, insisting that only the traditional meaning is correct.⁶⁵ Incidentally, when Charles Baron Clark suggested additional marks to be written above the notes to overcome the limitation of staff notation to represent shruti, he was evidently grappling with the confusion created by the multiple meanings of this terminology.⁶⁶

Thus, two aspects of shruti were constantly in focus throughout the eighteenth and nineteenth centuries. The first one related to the concept, number and mathematical pitch value, and the second one was its visual representation through the medium of notation. Only occasionally had its relation to performance practice been touched upon. Implicitly however, musicologists seem to have realized that its significance in performance practice was a moot issue, as its representation in transcription and notation rapidly disappeared.⁶⁷ While orientalist efforts were directed towards establishing the supremacy of ancient Sanskrit texts on music over actual performing practice laden with “Muslim” influences, the musical scenario in the nineteenth century was marked by the influence of Western models of intonation, notation systems and harmonization. These attempts at “modernization” of Indian music may not have borne great results, but they surely paved the way for successful advocates of reforms in Indian music in the twentieth century, such as Vishnu Digambar Paluskar and his contemporary, Vishnu Narayan Bhatkhande. Both these visionaries developed independent systems of notation by drawing upon existing systems of Indian notation, ancient and contemporary. Although both these systems are widely used even today, neither of them indicates microtonal intervals.

⁶⁴ See Tagore (1875), Ichalkaranjikar (no date), Pingle (1962), Anonymous author (1918). Roy Chaudhuri (2000: 75) also refers to this meaning of *murcchana*, and indicates that at present the term is no longer used in this sense. Many authors apparently mix up the two meanings of *murcchana*. See for example Pingle: 31, 56. It is also worth mentioning that in this context the term *murchhana*, as it appears in Devanagari script, has two versions, one ending with a long “a” sound (often transcribed as *aa*) and another with a short or mute “a”.

⁶⁵ Banerjee 1941: 14. However, nearly 60 years later when *Gita Sutra Sar* was translated into English by Himansu Sekhar Banerjee, the translator asserts that: “*Moorchhana* in modern Indian music signifies only ornamental phrases and similar embellishments with no particular notes or sequences of notes being affixed to any of them”. Ibid: 89. In this regard the translator quotes Sarngadeva and his commentator Simhabhupala, who seem to speak of the application of *murchhana* and *tana* in *desi* music, as graces or embellishments or as ornamental phrases. Ibid: footnote p. 89.

⁶⁶ Clark 1874: 257.

⁶⁷ This may be largely ascribed to the highly influential collection of notated Hindustani music by V.N. Bhatkhande, whose system of notation does not show microtonal intervals.

The Deconstruction of Shruti

When musicians speak of shruti they usually refer to a highly specific way of rendering a note within a raga. Musicologists have generally taken this to mean that the note in question should be performed at a specific – non-standard – pitch.⁶⁸ This confusion can easily be understood, as terms like *ati komal* (extra low) and *tivratar* (extra high) are often used in this context by musicians. However, musicologists went a step further and tried to relate the shrutis of the musicians to both the ancient Indian theories and the Western concept of just intonation. In the course of the twentieth century it became clear, mainly because of ever-improving methods for analyzing pitch in actual performance, that such a relation could not be maintained. What further confused the issue was that musicologists managed to involve practising musicians in their theoretical approach. The musicians themselves were attracted by this endeavour as it not only extolled their fine sense of tuning, but moreover showed this tuning to be based on a millennia-old tradition.

First Half of the Twentieth Century

In the twentieth century, the debate on Bharata's shruti theory centred on two contradictory viewpoints. One is represented by Bhatkhande, Telang, Popley, Ranade, Bake, Ratanjankar, Kaufmann and later Jairazbhoy, who all rejected the direct relevance of the Sanskrit treatises.⁶⁹ The second is represented by Deval, Clements, Fox Stangways, Daniélou, Bose, Lobo, Omkarnath Thakur and later Arnold and Bel, who rigidly maintained an unbroken link between the musical theory of ancient India and contemporary musical practice.

The view that the Hindustani tonal system consisted of seven main notes (called *suddha*, “pure”, corresponding to the Western major scale) and that five of these notes could be altered by a semitone, resulting in a 12-semitone system, was already presented in Ahobala's *Sangita-parijata*. This view was strengthened by the fact that the tempered harmonium proved sufficient as an instrument of accompaniment. Certainly, not all the notes of the harmonium were considered correct, but the small differences did not stop the harmonium from becoming increasingly popular as an accompaniment to vocal music.⁷⁰

⁶⁸ The opposed views are well described by Rabindralal Roy, who speaks of the mechanical and the aesthetic aspects of shruti. See the Official Report of the XXXIIIrd Madras Music Conference, 1959: 39.

⁶⁹ Rejecting the ancient theory of 22 shrutis does not necessarily mean that they altogether discarded microtonality. They do insist however that the ancient model could no longer be applied.

⁷⁰ Dilip Chandra Veda (1901-1994), who was not only a famous vocalist but also an eminent harmonium player, witnessed most of the debate about the harmonium and remarked: “the Ga [major third] of a harmonium is clearly too high, but when we sing, we sing the Ga of the tanpura [i.e. the harmonic major third]. The higher Ga of the harmonium does not disturb us in singing, it is very soft”. Personal communication, 1974, text in square brackets added.

It was however V.N. Bhatkhande, in his monumental contribution to Hindustani musicology, who explicitly stated that current musical practice had broken centuries ago with the ancient tradition of 22 shrutis and should be considered a 12-semitone system.⁷¹ His views provoked, and continue to provoke, highly emotional opposition from those who defend the theory of an unbroken heritage. Adherents of this opposition have included Hindu nationalists, with their fondness for the glorious past, as well as dissident Western musicologists, who tried to prove the superiority of a non-tempered, natural or just system of intonation.

Although professional musicians at large ignored the intellectual dispute on theoretical issues, some musicians and scholars played an important role in this debate. In this regard Harold Powers argues: “During the decades of growing Indian nationalism, Muslim musicians stood aloof, secure in their *gharanas* and their patronage, even though numbers of their coreligionists were active in other kinds of nationalist enterprise”.⁷² However, as noted by Ranade:

... very often, performers of great repute themselves wrote books, and these works most of the time spring a surprise on readers by their directness of approach, transparency of expression as also by the evident sense of reasonability felt by their authors – who were normally not well educated.⁷³

Celebrated vocalist and pioneer of the Kirana *gharana* Abdul Karim Khan (1872-1937), for example, collaborated with K.B. Deval and E. Clements in their research on intonation and musical scales. These scholars passionately believed in an unbroken continuity of the Indian tonal system since ancient times, a view later supported by Omkarnath Thakur and many others to this day.⁷⁴ They were strongly opposed to Bhatkhande’s view that, from the seventeenth century onwards the north Indian tonal system was essentially based on 12 semitones as described in Ahobala’s *Sangita-parijata*. Instead, they tried to reconcile the ancient scales of 22 shrutis with the modern scales, much in the same way Paterson had done before them .

On the basis of pitch measurements with a diachord, Deval came to the conclusion that a two-shruti interval equals a just semitone (112 cents), three shrutis a minor tone (182 cents) and

⁷¹ For a survey of Bhatkhande’s work see Nayar, 1989. His ideas about the study of Sanskrit treatises are summed up on p. 107.

⁷² Powers 1980: 26. For example, the work of Abdur Rehman Chughtai (1897-1975), an outstanding Muslim painter from Lahore (which is now in Pakistan), represents the awakening of Muslim political and cultural identity in India as partly in response to Hindu cultural nationalism. See Mitter 2001: 181.

⁷³ Ranade 2000: 9.

⁷⁴ Thakur 1961, *passim*.

four shrutis a major tone (204 cents).⁷⁵ How he arrived at these equations is unclear, and nowhere does he provide information on what he actually measured and whether musicians referred to such intervals as two, three or four-shruti intervals. On the basis of his deductions he constructed a shruti harmonium.⁷⁶ While insisting that the shrutis are not all of the same size, he claimed that the intervals of Sarngadeva were not mere theoretical formulations, but are actually the ones practiced during his own (Deval's) time.

Along the lines of the Asiatic Society of Bengal, Ernest Clements and K.B. Deval founded the Philharmonic Society of Western India in 1911. One of the primary objectives was to examine and formulate an opinion regarding the scales given by the ancient text-books and those in use in their time. Deval, in his introductory speech, asserted that "the aim of the society has been throughout, to swerve not an inch from the old theory and at the same time to devise a method of teaching intonation which will be reasonably simple".⁷⁷ He tried to lend credibility to the work accomplished by the above society:

The theories expounded by these books (published by the society) have been put to searching tests by noted musicians such as Abdul Karim Khan, Barkatulla Khan, Murad Khan, Alladiya Khan, Wahid Khan, Balkrishnabuo Ichalkaranjkar, G.B. Acharekar and late Bhayya Joshi.⁷⁸

Clements' grave concern about the state of Indian music, especially the aspect of intonation, is apparent in his statement: "Theory is practically non-existent – Correct intonation is only to be found practiced by a few professionals and they cannot impart their secrets, except by example".⁷⁹ He upheld Deval's conclusions as "beyond controversy" and even claimed to supplement the pitch-related data of Deval.⁸⁰ While maintaining that his own measurements concerning many north Indian ragas did match the corresponding intervals of Deval's harmonium, he believed that there were more than 22 pitches to the octave used in Indian music, although the 22 shrutis of Deval's harmonium were the most common.⁸¹ Clements remarked that:

⁷⁵ This view had been stated as early as 1807, by J.D. Paterson. See footnote 46.

⁷⁶ Inspired by the works of Western musicologists such as Helmholtz, E. J. Ellis and others relating to acoustic measurements of intervals, this special instrument was claimed to have been devised to suit the specifications of Indian music. It was manufactured by Moore and Moore Company of London. This shruti harmonium was equipped with a keyboard supposedly tuned to shrutis – microtones of different ragas.

⁷⁷ Anonymous 1918: III-14.

⁷⁸ Ibid: III-15.

⁷⁹ Clements 1927: 5.

⁸⁰ Clements 1912: 6.

⁸¹ The shruti harmonium of Deval did not achieve any popularity in India, least of all in replacing the harmonium based on the 12-semitone Western tempered scale.

... they (hereditary vocalists) have the shruti-difference of the ragas fixed in their memories. We can only fix them by setting up a standard tuning for the harmonium. No other instrument (except the shruti harmonium) will serve the purpose.⁸²

Nonetheless, on the basis of demonstrations of the shruti harmonium at the First All-India Music Conference in Baroda (1916), it was concluded that the scales and intervals suggested by Clements for the ragas Kaphi, Khamaja and Bilawal did not tally with those sung by the performing artists, including the celebrated dhrupad singer Zakiruddin Khan of Udaipur. *Binkar* Mushraf Khan of Alwar remarked that for all practical purposes the usual method of describing ragas in terms of the commonly accepted 12 notes was quite adequate and proper.⁸³

Like Deval, Clements arrived at his interpretations mainly by inductive reasoning, taking as his point of departure that Indian music was essentially based on just intonation. He dismissed the idea of quarter tones in Indian music. For him the subtle difference of shrutis was comparable to the difference between the major and the minor whole tone. Interestingly, he admits in his introduction that shruti is rarely used in scales, but rather as an element of ornamentation.⁸⁴

Clements insisted on interpreting many elements of the ancient theory in terms of just intonation and emphasized the importance of the harmonic series of just intonation. He was firmly convinced that the twentieth-century practitioners of music followed the shruti theory. Further he claimed that in stringed instruments, although the fret placements may correspond to the 12-semitone system, microtonal intonation was achieved by a sideways deflection of the string.⁸⁵ He was of the opinion that Western musicians also employ such microtonal variations, although theoretically they subscribe to the 12-semitone tempered scale. Through his lecture-demonstrations Clements attempted to prove that the difference in *rasa* or the emotional effect between the ragas was entirely due to shruti or quarter tone differences between scales.⁸⁶

⁸² Anonymous 1918-23: III-16.

⁸³ The First All-India Music Conference 1917: 23, 29-30.

⁸⁴ Clements 1918.

⁸⁵ Clements 1927: 2.

⁸⁶ Anonymous 1918-23: III-16. Here also terms such as quarter tone and microtone are loosely used to denote shruti. See also fn. 1. It is a curious detail that Clements extensively thanks V.N. Bhattachande in his "Introduction" for helping him in reading the Sanskrit treatises on shruti, when we realize that these two authors reflect diametrically opposed views, that would remain a bone of contention for almost a century.

Following Deval and Clements, Fox Strangways also assumed Bharata's 4, 3, and 2 shruti intervals to be the major tone, minor tone and semitone respectively of the just scale.⁸⁷ He strongly argued against the notion of the shruti system being evolved from a conscious division of the octave into 22 parts and put forth his own model based on the simple division of a vibrating string length, resulting in a just scale.⁸⁸ Also inspired by Deval and Clements, G.B. Acharekar (1885-1939) constructed a harmonium which he called *svarasamvadini*.⁸⁹ The instrument supposedly had arrangements to play the Western tempered scale as well as the 22-shruti Indian scale.⁹⁰ There is practically no information about its construction. The system of allocating shrutis seems quite different from that proposed by Deval and Clements.⁹¹

V.N. Bhatkhande, the most influential theorist of the early twentieth century, observed that nearly all the more recent Sanskrit and vernacular works described ragas using only 12 tones, and did not mention more than 12 frets for the vina octave.⁹² According to him, these writers attempted to describe and distinguish ragas in terms of *aroha*, *avaroha*, *vadi*, *samvadi*, etc., rather than by dwelling upon discussions involving shrutis. But Bhatkhande also made an attempt to reconcile the conflicts between ancient and modern systems, and proposed the following distribution of shrutis among the 12 semitones.⁹³

Sa		Re ^b		Re		Ga ^b	Ga		Ma	
1	2	3	4	5	6	7	8	9	10	11

Ma [#]		Pa		Dha ^b		Dha		Ni ^b	Ni	
12	13	14	15	16	17	18	19	20	21	22

Bhatkhande considered the present-day Hindustani *suddha* (natural) scale, Bilaval *that*, as a just major scale with a raised or Pythagorean sixth degree.⁹⁴ Notice however that he suggests that the interval from Ni to Sa' would be a just semitone, which is not the case in actual practice.⁹⁵ A staunch proponent of flexible intonation, he recognized a correlation of pitch with melodic context. While suggesting that terms such as *ati komal* and *tivratar* are

⁸⁷ According to Fox Strangways (1914), the difference between the note *pancham* of the two *grama* is the comma of Didymus, or the difference between a major and minor tone.

⁸⁸ Fox-Strangways 1914: 129.

⁸⁹ Acharekar 1974: 117-18.

⁹⁰ It was claimed that the instrument had the possibility of playing embellishments such as *mind*, a feature missing on the normal harmonium.

⁹¹ Acharekar 1974: 292, chart 36.

⁹² Bhatkhande 1934: 38.

⁹³ Bhatkhande 1952: 9.

⁹⁴ Bhatkhande 1934: 34.

⁹⁵ Meer 2000

superfluous in describing features of present-day ragas, he also made broad and non-specific statements such as: "... certain notes are said to vary slightly in pitch from one raga to the next". He cites an example of *komal* Dha in the raga Asavari, which is supposed to be lower than the same note in raga Bhairavi.⁹⁶

In an extraordinary and voluminous work on shrutis, Abraham Pandither, a proponent of equal temperament, joined forces with V.N. Bhatkhande and opposed the findings of the Philharmonic Society. Tracing his views to millennia-old Tamil sources, he divided the octave into 24 equal parts and designed a vina accordingly. During the Baroda conference he arranged a demonstration intended to show that the scales of Indian ragas could be reproduced exactly on the tempered harmonium. He had taught his daughters to sing in accordance with this instrument. The outcome of the demonstration "was equally accepted by amateurs and professionals alike".⁹⁷ The work of Pandither is on the one hand a very meticulous and thorough examination of the theories on shrutis that were known to him, giving many detailed tables comparing the different views, while on the other hand, like so many writings on shruti, it is a monumental construction of deductions. This, combined with the biting sarcasm with which he dismisses all other theories, makes his work the prototype of shruti scholarship gone wild. In his particular case the shruti is instrumental in showing that Tamil culture is at the root of all forms of highly developed art music – not only of the Indian subcontinent – but also of ancient Greece, Mesopotamia and Egypt!⁹⁸

Going even further, Firoze Framjee defined the notes of 170 ragas in terms of shruti intervals and vibrations, and then classified them according to the traditional *murchhana* system.⁹⁹ Emulating the approach adopted by post-medieval scholars as well as by his own father, B.G. Acharekar attempted to discuss intonation in present-day music on the basis of the tuning of sitar strings and fret positions.¹⁰⁰ Following the principle of perfect fourths and fifths to be maintained between the *vadi* and *samvadi* notes, he defined notes in various ragas in terms of

⁹⁶ Jairazbhoy 1971: 66. Some of these observations need to be verified experimentally in order to put an end to such speculations.

⁹⁷ Anonymous 1918-23: II- 36. Based on this incident it should not be construed that Bhatkhande was in favour of equal temperament because in a letter to Pandither he writes, "I never had a shruti theory of my own". See Anonymous 1918-23: II-37.

⁹⁸ Pandither 1917, passim.

⁹⁹ In a rather immature way it is claimed that "the author, therefore has, after years of intensive efforts and research succeeded in solving the problem of the traditional shruti theory and proved by concrete facts and accurate mathematical figures in this treatise that the scale used by our modern musicians is the same as that expounded by Bharata in the early part of the sixth century". See Framjee 1934: 9. Also see chart 12, indicating the pitch of different notes in terms of vibrations per second, as supposedly used in different ragas.

¹⁰⁰ Acharekar 1974: 331-97.

vibrations per second. This was yet another hapless attempt at validating the 22-shruti dictum of Bharata in terms of modern scientific concepts.¹⁰¹

G.H. Ranade supported the view that theoretically there are 22 equal shrutis in an octave. However, he maintained that in practice, these ratios get modified for aesthetic reasons.¹⁰² He defended flexibility of intonation by stressing that the positions of shrutis may vary considerably in accordance with their melodic context even within a given raga.¹⁰³ He also observed a definite influence of factors such as amplitude, timbre and overtone structure on pitch perception. Whilst he seems to have been convinced about the significant role played by the drone harmonics in intonation, Ranade made no attempt to explain the details of this phenomenon. He observed that in certain ragas there is no agreement among the artists about the degree of flatness or sharpness of a note. In such cases, he advocated the significance of tetrachordal symmetry as a guiding factor for intonation.¹⁰⁴

The Dutchman Arnold Bake was one of the few scholars who argued that for Bharata shrutis were of equal measure. However, like Fox Strangways, he too was opposed to the theory of the conscious division of an octave into 22 parts. According to him, the number 22 resulted merely because of the presence of three intervals of four shrutis each, two intervals of three shrutis each and two intervals of two shrutis each.¹⁰⁵ He also stressed the importance of shrutis in ornamentation.¹⁰⁶

O. Goswami submitted the hypothesis that Bharata's *pramana* shruti had evolved from the differences between vocal and instrumental music.¹⁰⁷ He believed that Bharata was greatly influenced by the ancient Greek tetrachord theory.¹⁰⁸ Speaking of intonation in modern practice, he maintained that ragas can be distinguished on the basis of shruti alterations. Like later scholars including Daniélou, he proposed a system of 66 shrutis and even believed in the supposed ability of the singers to reproduce them accurately in a performance.

Narendra Kumar Bose's *Melodic Types of Hindustan* (1960) is second only to the monumental and confounding work of Abraham Pandithar mentioned above. The major portion of the work is devoted to a general theory of tuning and scales, using a system of 53

¹⁰¹ The author even distinguishes between ragas like Bhupali and Deshkar on the basis of note-positions expressed in terms of cycles per second, viz. augmented Re for Bhupali and consequently, also the higher position for Pa.

¹⁰² Ranade 1957: 37.

¹⁰³ Ibid: 33.

¹⁰⁴ Ranade 1951: 194.

¹⁰⁵ Bake 1957: 67.

¹⁰⁶ Bake 1930: 6.

¹⁰⁷ Goswami 1957: 30. Here, Goswami suggests that vocal music during Bharata's time was in Pythagorean tuning and the instrumental music was in just tuning based on simple divisions of a vibrating string.

¹⁰⁸ Ibid: 39.

comma-shrutis. In his historical survey he observes that there is no continuity from ancient to modern times. He argues that the shrutis only have theoretical significance, and there is really no evidence indicating their practical utility in the ancient treatises.¹⁰⁹ He concludes that the concept of shruti was merely meant to provide a convenient method for comparing different intervals with respect to their sizes.¹¹⁰ However, he contradicts his own viewpoint by providing a complex theoretical system concerning intonation based on microtones. Inspired by the system of Western staff notation, he presents a system in which vowel change and diacritical marks are applied to the note-syllables for indicating microtonal alterations.¹¹¹ In his system, each of the seven svaras have seven possible positions. In the final chapter Bose rises to unusual heights when he inductively arrives at the position of the notes of a number of ragas in relation to his system of 53 shrutis, “correcting” the ragas in the process.¹¹²

The French musicologist Alain Daniélou, a staunch supporter of the Hindu cause, counterbalanced the authors who had a more pragmatic view of the phenomenon of shruti. He insisted that north Indian music had remained substantially unchanged since ancient times, and hence, that modern performance practice corresponded closely to the ancient theoretical formulations concerning the shruti.¹¹³ Like Deval and Clements, Daniélou believed that the ancient 22 shrutis were not equal in size. Whilst arguing that they were merely the 22 most commonly used pitches chosen out of a much larger number of possible ones, he formulated his own elaborate system of 66 shrutis, out of which he finally arrived at 53 harmonically acceptable pitches.¹¹⁴ Like Clements, Daniélou has also given transcriptions indicating the precise pitch position of the notes of various ragas. The author, however, provides no details of the methods by which he has arrived at these conclusions.¹¹⁵ He indicates that current performance practice shows consistent usage of his 53 shrutis, but at the same time realizes that the specific and subtle emotional qualities of each interval are not confined to strict mathematical ratios. Probably because he himself used to play the *bin*, he understood that there was an intimate interrelation of pitch and melodic context.¹¹⁶

Deep into the 20th centuries musicologists went on speculating about the shrutis with purely inductive methods, at best using a monochord for measuring intervals. Yet, as early as the

¹⁰⁹ Bose 1960: 57.

¹¹⁰ Ibid: 198-199.

¹¹¹ Ibid: 30-31.

¹¹² Bose 1960: chapters XV-XVII.

¹¹³ Daniélou 1968: 5.

¹¹⁴ The criteria for acceptability are not clearly defined by the author. Daniélou’s model of 66 shrutis was admittedly based on the concept put forward by Kohala, whose work has not survived. However, Matanga has often referred to Kohala’s contribution.

¹¹⁵ Daniélou 1968: 38.

¹¹⁶ This observation has later been supported experimentally by scholars such as Levy, Bel and Rao.

1930s there were attempts at a scientific, empirical approach to measuring shrutis. Notably C. Subrahmanya Ayyar, a violin player from South India, went to London to make oscillographic recordings of his violin play at the National Physical Laboratory at Teddington.¹¹⁷ He arrived at the conclusion that many more shrutis (in the sense of pitch positions) were used in an octave than 22. He has only made passing notes on Hindustani music, but the fact that accurate measurements were possible at the time is important enough to notice.

In North India Nazir Ali Jairazbhoy was the first to conduct empirical research on intonation used in current performance practice. At the time the techniques for doing such work were limited and posed technical and methodological problems.¹¹⁸ But the outcome of his work, done together with Stone, was so remarkable that it should at least have inspired researchers to verify the results and work on better techniques. In order to ascertain whether there is a variation in the intervals used by the musicians in specific ragas, and whether the intervals are always the same throughout the performance, Jairazbhoy and Stone conducted experiments involving six recordings of a raga by six different artists.¹¹⁹ On the basis of this research, Jairazbhoy and Stone conclude that accuracy of pitch is relative and subjective rather than consistently precise. Moreover, they found that intonation in performance practice could not possibly be explained by any of the extant theories, least of all the theories that maintained that intonation of Hindustani music had an unbroken link with the millennia-old shruti models.

Of course, the time was ready for this kind of approach, for in the middle of the twentieth century a majority of authors on shruti adopt the view that in contemporary music shrutis exist, but that they have little or nothing to do with Bharata's shrutis. Popley (1921), Ranade (1957), Sanyal (1959), Ratanjankar (1961) and others advocate a humanistic model that has aesthetic considerations rather than mathematical formulations alone to address the question of shruti. For Ratanjankar, Bharata's concept of shruti was a device to indicate relative interval size. Pointing to the fact that the definition of raga contains no reference at all to shrutis, like Baki, he maintains that these microtonal subtleties are confined to embellishments and have a specific aesthetic purpose.¹²⁰

¹¹⁷ Ayyar 1951: 138. We are indebted to Arvinth Krishnaswamy for indicating this to us.

¹¹⁸ Bel 1984.

¹¹⁹ Jairazbhoy and Stone 1963: 130-31. The raga selected was Yaman and the artistes chosen performed on flute, sarangi, sitar and voice. The limitation of this work was that, only three intervals viz. Sa-Re, Re-Ga and Sa-Ga were analyzed. The steady part of the note was considered for determining its frequency. Jairazbhoy points to the difficulty involved in precisely defining the exact pitch of any particular note.

¹²⁰ Ratanjankar 1961: 191.

According to Harold Powers, modern Indian music is largely based on just intonation.¹²¹ He criticizes the model adopted by Deval and Clements as a combination of hypothetical acoustics and ancient treatises cited without regard for time or place of origin. He notes that their results are simply too good to be true.¹²² Further, he suggests that these mathematical speculations should also take into consideration the actual views of the performers themselves regarding their own intonation.¹²³ Walter Kaufmann, another proponent of flexible intonation, believed that north Indian performers are entirely uninfluenced by the shruti theory. Instead, he maintained that they are solely guided by the sentiment or mood of the raga, for achieving the required intonations.¹²⁴ Based on his analysis of raga Marva, Kaufmann predicted a gradual decline in the significance of microtonal alterations in modern Indian music. He lamented: “An examination of live and recorded performances of this raga shows a glimpse of the road along which future Indian music will travel – away from microtonal alterations”.¹²⁵

Assuming that all the 22 shrutis of Bharata were exactly equal in size, Modak emphasized a close approximation of the 22 equal shruti system to just intonation, with an error no greater than 1.4 per cent as compared to the maximum 3.4 per cent error of 12 tone equal temperament.¹²⁶ His experiments, involving measurements of string-tunings by two performers, suggest that the propriety of intonation in a given raga varies from one performer to another.¹²⁷ The limitation of his work, however, is that it is conducted in an artificial setting without consideration for actual performance context.¹²⁸

B.C. Deva believed that the essence of Indian music lies in the micro-distinctions made in the pitches of svaras.¹²⁹ On the one hand, citing the experimental work of Ellis, Deva upheld the “holy” figure of 22; on the other hand, he argued against it on the basis of his own experimental work, in which he obtained nearly 40 tones between Sa and Ga alone.¹³⁰

¹²¹ Powers 1962: 225.

¹²² Powers 1965: 4-5.

¹²³ Bel reports an incidence which clearly indicates a need for such interaction with the performers. He concludes that: “... it is quite useless to analyze recordings without getting the musician, who himself made the recording, to tell where he/she felt that he/she had or hadn’t properly executed his/her intention”. See Bel 1983: 43.

¹²⁴ Kaufmann 1968: 9.

¹²⁵ Ibid: 1968: 316.

¹²⁶ Modak 1967: 153. As pointed out by Levy, this figure applies only if the major third, perfect fourth and perfect fifth are considered. The error seems to be greater if additional intervals are also included. See Levy 1982: 61.

¹²⁷ Levy 1982: 79.

¹²⁸ Modak provides few details about the background of the subjects, analysis of the data and its interpretation.

¹²⁹ Deva 1973: 16.

¹³⁰ It was shown that to produce a just noticeable difference in pitch, a string length must be shortened by 1/32 of its previous length. Deva observes that the number of such increments in the octave is 21.98, almost 22. See Deva 1965: 60-61. Without giving adequate references, he cites findings of other experimenters suggesting that a normal ear can discern a pitch difference of 3-5 cps. [cycles per second] and this would result in approximately 80 microtones to the octave.

Further, recognizing the significance of the melodic context, he noted that it is practically impossible to measure all the pitch variations of *gamak* (shakes) and *mind* (glides).¹³¹ He dismissed the numerous attempts made at reconciling the ancient theory and modern performance practice because of the lack of concrete evidence supported by accurate acoustical analysis.¹³²

In claiming that the intonation in certain ragas may have been influenced by the advent of the drone, Deva presents an interesting hypothesis that raises many more questions, related not only to intonation, but also concerning the origin, history and significance of the drone.¹³³ While earlier musicologists have occasionally hinted at the fact that for musicians, shrutis form part of specific ornamentations, Deva makes an explicit case for this approach to the concept. As performing musicians have already known and been practising all along, he includes the shrutis as a pitch area rather than an exact pinpoint, in his model.¹³⁴

A.D. Ranade has elaborated this concept further by suggesting that a *svara* has both a tonal centre and a periphery. Thus the tonal range of any given *svara* is defined when both are put together. Further, he specifies that the tonal range is related to the melodic context. Based on this model, he attempts to define finer levels of intonations such as *kansur* (marginally off pitch) and *besur* (clearly off pitch).¹³⁵

In a later article on the origins of the shruti theory, Jairazbhoy suggests that all shrutis were considered equal by Bharata, although they may not have been mathematically equal in practice. In an attempt to explain the origin of 22 shrutis proposed by Bharata, Jairazbhoy analyzed the Tamil style of Rgveda and Yajurveda recitations. On the basis of this work he proposed that Bharata's shruti formulation was originally used to determine the interval sizes of Vedic chant which were then applied to the theory of secular music. According to Jairazbhoy:

¹³¹ Deva 1967: 109 and 1965: 59.

¹³² Deva 1967: 38.

¹³³ Although Clements strongly believed that the drone accompaniment existed even during the time of Bharata, most of the modern scholars like Deva claim that it was not until the seventeenth century that the drone was included as a definite component of a musical performance. See Deva 1967: 71, 56. Based on preliminary investigations, Rao (2000) observed a significant shift in the frequency values of Ma[#], Pa, Dha and Ni, depending upon the type of tuning. In the case of Pa-tuning (of the first string of the tanpura), two references, Sa and Pa, are available. As these reference points are at the beginning and the middle of the scale, they lend appropriate guidance for intoning all the notes, whereas in the case of Ni-tuning, which is also popular among singers (even when the raga allows Pa), both these reference points are at the same extremity. This may affect the intonation of notes from Pa onwards.

¹³⁴ Deva 1965: 64. This observation is further strengthened by the experimental findings of Levy, Bel and Rao.

¹³⁵ Ranade 1971.

... a single shruti appears to have been conceived as the highest common factor of the existing intervals, and not as a musical tone in its own right The total number of shrutis in the octave, i.e. 22, is only incidental, being determined by the size of the unit of measure. It did not imply that there were 22 tones in the octave¹³⁶

Continuing the trend set by Clements, Deval, Acharekar and Thakur, Brahaspati constructed a special string instrument, *sruti-darpan*, to explain Bharata's 22 shrutis. On the basis of this research, he proposed that the shrutis are of unequal measures.¹³⁷ According to him, it is not without purpose that Bharata chose to expound the shruti system only after having dealt with aspects such as *svara* and *grama*. Further, the author made an attempt to discuss the notes of ten *that* of north Indian music in terms of the tonal structure (based on shrutis) supposedly defined by Bharata.¹³⁸ As in the case of his predecessors, his theoretical work remains speculative.

Recent Developments

It is truly amazing that the empirical work done by Nazir Jairazbhoy did not stop a number of authors from reinventing the "shruti-wheel". In fact, to this day there are many musicians and musicologists who maintain that Bharata's theory of shrutis is a theory of just intonation and that Indian musicians continue to perform those shrutis.¹³⁹ Around 1980, Mark Levy, a student of Jairazbhoy, carried out extended research on intonation in a single performance, in multiple performances by the same musician and in multiple performances of the same raga by different musicians.¹⁴⁰ In addition, relationships between pitch variations and melodic contour were examined. Through his experimental findings, Levy noted a strong influence from the melodic context. He concluded that intonation in north Indian music appears to be based on a flexible system of 12 semitones, and that no consistent correlation can be observed between the measured pitches and any single theoretical system.¹⁴¹

As is usual, any attempt to contradict the classical shruti theory was countered by a group of scholars trying to prove the opposite. Bel constructed another shruti harmonium which could be digitally programmed with an accuracy of about one percent.¹⁴² However, attempts made

¹³⁶ Jairazbhoy 1975: 54.

¹³⁷ Jaidev Singh notes an influence of Prof. Muley's work upon Brihaspati's thoughts on this subject. See Singh 1989: 9).

¹³⁸ Brihaspati 1976: 285-89.

¹³⁹ Extremely elaborate schemes of this type are regularly offered for publication.

¹⁴⁰ Levy 1982: 8.

¹⁴¹ Ibid: 142. Experimental findings of Bel and Arnold (1983) suggest that Levy's formulations are rather oversimplified.

¹⁴² Bel 1983: 42.

at determining “ideal” shruti positions for different ragas, did not yield consistent results.¹⁴³ The failure of this shruti harmonium in directly establishing the tones led to the construction of the Melodic Movement Analyzer (MMA). Bel claimed that:

... since no single existing machine available for acoustic analysis can be perfectly adapted to meet the demands of analysing monodic music like Indian music, MMA is specially designed With a measurement accuracy better than one cent, MMA surpasses the performance of a melograph.¹⁴⁴

Bel made a strong point of criticizing Levy’s methods and especially his techniques.¹⁴⁵ Levy had worked with the strobo-tuner technique introduced by Jairazbhoy.

The enormous amount of data processed by the MMA showed that intonation is certainly not a pinpoint phenomenon. To this extent, it supports the views of Jairazbhoy, Stone, Levy and Deva that pitch in performance occurs in tonal ranges rather than exact points.¹⁴⁶ However, it strongly argues against the extent of the tonal range given by Levy’s findings. Using the MMA, Bel and others showed how the performances of reputable musicians reveal that they do try to place the notes in a much more accurate way than “tempered \pm 30 cents.” The authors also found that musicians achieve meaningful differences in intonation in different ragas, and argued that these differences could be connected to the ancient shruti theory.¹⁴⁷ One of the members of Bel’s team had earlier written articles that were based on the Deval-Clements model of shrutis, and if anything, the goal of the team’s work was to validate the old model.¹⁴⁸

However, Meer soon realized that the actual measurements did not tally with any interpretation of the ancient shruti model, as had been concluded earlier by Jairazbhoy and Levy.¹⁴⁹ Moreover, although the MMA was a major technological advancement, it did not take into consideration the modern developments in the field of pitch perception. Meer had earlier suggested that the term shruti should be understood as a tonal configuration rather than a deviation from a pre-determined ratio, along the lines earlier expressed by G.H. Ranade.¹⁵⁰

¹⁴³ This was probably because of the sensitivity of musicians’ ears and the disposition to search for a pitch with extreme care. Also, there was a technical disadvantage of having to program the note-positions rather than simply having to tune them. See Bel 1983: 42.

¹⁴⁴ Bel 1983: 46. For the technical details of this machine, see Bel 1983: 45-48.

¹⁴⁵ Levy’s study draws inspiration from the work of Jairazbhoy and Stone who proposed that “... any intonation within certain limits (perhaps 25 to 30 cents on either side of the tempered intonation) can be acceptable”. See Jairazbhoy and Stone 1963: 130-31.

¹⁴⁶ Deva 1965: 23. Arnold *et al* 1984-85: 47.

¹⁴⁷ It has been pointed out that even some of the data presented by Levy could have led him to similar conclusions. See ISTAR 3-4, 1984-85: 47.

¹⁴⁸ Arnold 1974.

¹⁴⁹ Meer 2000.

¹⁵⁰ Meer 1980: 10.

Comparing the varying positions of *komal* Ga in ragas Sindhura, Bahar, Malhar, Suha Kanada and Barva, he suggested that the totality of the sound of a note in a raga is defined by its scale, melodic pattern, and its specific melodic treatment.¹⁵¹ Rao's analysis (1990) using the MMA provided further support for the view that pitch values for different notes are neither rigidly fixed nor randomly varying and in fact, the musicians do seem to conform to a particular range of pitch values for a given raga. Further, the same performances, examined using another independent system (LVS) based on contemporary pitch perception theory, validated the results concerning pitch positions.¹⁵² Thus the viewpoint expressed by Bhatkhande, Ratanjankar, Daniélou, Deva, Meer and others, that the pitch is related to melodic context, has been verified empirically.¹⁵³

Conclusion

Contemporary musicians use the word shruti in conjunction with highly specific ornamentations of particular notes in particular ragas. Thus, they speak of the shruti of *komal* Ga in the raga Darbari, the shruti of *komal* Ni in the raga Bhimpalasi or the shruti of *komal* Re in raga Bhairav. Many musicologists have tried to link this contemporary practice with ancient musicological theory, sometimes going to the extent of suggesting a "correction" of contemporary practice on the basis of highly speculative theories. Apparently, the ancient and contemporary meanings of shruti are fundamentally different. Most scholars have related the ancient concept of shruti to pitch positions or tuning schemes, whereas the current meaning of shruti seems more related to ornamentation, or to put it in the words of Nicholas Cook, "music between the notes".¹⁵⁴ Yet there are grounds to assume that even in ancient times shruti could denote an inflection of a note, as can be seen in both the *Naradiya-siksha* and the *Abhinava-bharati*.

Bharata's *Natya-sastra* has been for nearly two millennia a dogmatic starting point for discussions of shruti. Both Sanskrit treatises and interpretations in modern languages, including English, have taken Bharata's system of 22 shrutis divided in specific ways over 7 svaras as an axiom. How this division could be related to string lengths or frequencies

¹⁵¹ Ibid: 18-19.

¹⁵² LVS was based on subharmonic summation which is a direct implementation of the concept formulated by de Boer (1977). For more information, see Rao 2000: 65 and the website of de Boer: www.praat.org. Currently the best system for this type of analysis is PRAAT, also developed by de Boer.

¹⁵³ These results are based on the pitch measurements of "standing notes" that are audibly perceived as "steady notes" (or the notes which are judged as *khada sur*). The criteria for measuring a steady note were evolved after realizing the difficulty associated with accurately measuring "the ideal pitch" of a note of shorter duration, linked by either descending or ascending melodic contexts. In Indian music, glides and undulations are so common that only 10-20 % of even the *alap* section of a performance consists of so called "steady notes".

¹⁵⁴ Cook 1998: 55-56. S. N. Ratanjankar literally used the expression 'music between the notes' much before Cook did. See the Official Report of the XXXIIIrd Madras Music Conference, 1959: 42.

became a subject of much speculation from the time of Ahobala onward. It was in this period that musicologists became aware of an increasing gap between theory and practice. On the one hand they continued to delve into the ancient system of 22 shrutis, but at the same time they conveniently adopted the 12 semitone model for describing contemporary performance practice based on a fixed position of the drone (Sa), resulting in various scale types. Thus there appears to be a dilemma of respecting the tradition, but at the same time resorting to new models of intonation. As has been pointed out by Widdess, most authors have over-emphasized the acoustic aspect of consonance (nine and thirteen shruti intervals – the perfect fourth and fifth) whereas from early times the *functional* aspect of consonance (melodic symmetry) has played a very important role.¹⁵⁵

During the twentieth century, Bhatkhande, Bake, Ratanjankar, G.H. Ranade and Meer acknowledged the significance of microtonal inflections, especially with respect to ornamentations. At the same time, they pointed out that north Indian ragas cannot be differentiated on the basis of pitch difference alone. Given the flexibility of intonation in modern raga performance, they rejected the validity of applying the convention of shruti as a fixed pitch.

Among several attempts made by twentieth-century scholars to understand, if not resolve the complex issue of shruti, the following are noteworthy for their findings and observations, which also provided a meaningful direction for subsequent studies: V.N. Bhatkhande suggested a correlation between pitch and melodic context which was later supported by G.H. Ranade, Ratanjankar, Daniélou, and Deval, and still later it was experimentally verified by Jairazbhoy & Stone, Levy, Bel and Rao. G.H. Ranade suggested a comprehensive model to include the influence of amplitude, timbre and overtone structure on pitch perception, in order to arrive at meaningful conclusions regarding intonation.¹⁵⁶ Since the mental conceptualization of a given pitch precedes its actual expression through sound-producing mechanisms, Powers suggests that appropriate consideration be given to the actual views of the performers themselves regarding their own intonation. It is indeed vital to understand the musicians' ideas and impressions in order to arrive at any judgment regarding actual intonation.

B.C. Deva and A.D. Ranade independently suggested that shrutis had to be looked at as continuous pitch areas rather than exact pinpoints. This idea is further supported by the work

¹⁵⁵ Widdess 1995: 210-11.

¹⁵⁶ The subjectivity involved in human auditory perceptual mechanism complicates this issue. Some of the studies undertaken in the area of psychology of pitch perception have concluded that in the case of more complex tones or combination of tones, subjective pitch may not correspond to any measurable frequency in the originally presented sound. See Plomp 1976: 112-14 and Ward 1954: 369-80.

of Levy, Meer, Bel and Rao from which it perspires that pitch in performance must be seen as a statistical phenomenon.

For any kind of non-standard intonation the melodic contours seem to be musically more significant than simple pitch information in terms of frequency, and the melodic shape of or around a note needs to be studied.¹⁵⁷ In performance, musicians' efforts are constantly directed towards achieving specific tonal configurations. When a performer succeeds in this endeavour, knowledgeable audiences immediately respond by showing their appreciation, clearly relating the specific tonal configuration to the core of the given raga.¹⁵⁸ As suggested by Bake and Ratanjankar, and emphasized by Meer, the microtonal subtleties of shruti in present-day performance practice are meaningful and significant with respect to *raga-specific ornamentations*.

The multiplicity of views presented in this study suggest that despite all efforts, interpreting Bharata's system of 22 shrutis remains enigmatic. Perhaps it is time to realize the futility of seeking a direct connection with the ancient and medieval sources. Perhaps it is time to give up attempts at reconciling discrepancies between ancient theory and modern-day performance practice. Since the musical tradition and allied concepts prevalent in Bharata's time (such as *grama*, *murchhana*, *jati*, etc.) have undergone slow, yet definite transformation leading to the emergence of different musical systems, how can one justify applying the same age-old norms of 22 fixed pitches to interpret intonation in present-day raga performance?

As theorized by Bharata, shrutis seem to be pinpoints with a fixed mathematical relation to each other within the range of an octave. Even the medieval and post-medieval theorists continued to struggle with this interpretation of shruti, later given in terms of string lengths of the vina. Experimental studies conducted during the twentieth century provide evidence for flexible intonation, ruling out the notion of pitch as fixed points. Modern scholars have observed intonation as a statistical phenomenon in which the note densities occur not as exact points but rather as ranges within a certain tonal region. The influence of melodic context on pitch is also clear from these studies.

The above-mentioned raga-specific intonations can only be studied by adding the dimension of time. The melodic shapes of these intonations can be appreciated by examining the relation between the tonal space and time. It is interesting that Abhinavagupta also noted that time was one of the determinants of shruti. Hopefully, in the near future, advances in electronic and computer technology will greatly facilitate the compilation of a much greater body of

¹⁵⁷ The expression melodic shape implies pitch in time and does not refer to the form of objects in space.

¹⁵⁸ It is not uncommon to have appreciative remarks such as "*kya gandhar lagaya hain*", meaning "*What an intonation of gandhara*", from a knowledgeable audience.

additional data to investigate the preliminary research done so far, to arrive at more meaningful formulations regarding intonation in contemporary north Indian music. Further, a third dimension of “colour”, to include timbre and volume, could be added to the above model in order to evolve a holistic picture of “sound gestalt”.

Throughout this paper it was observed that musicians have their own views on intonation, which are mainly handed down within the tradition. Maybe at times they are not consciously aware of academic traditions and hence may not be in a position to express their ideas in terms of theoretical formulations. However, their ideas are implicit in musical practice as the musicians visualize tones, perhaps not as fixed points to be rendered accurately every time, but rather in terms of tonal regions or pitch movements defined by the grammar of a specific raga and its melodic context. They also attach paramount importance to certain raga-specific notes within phrases to be intoned in a characteristic way. Hence, we need to understand what the performers have in mind about their intonation and how they relate these concepts to the actual intonation. Our understanding of human perception of sound in general as well as that of tones in the context of musical performance also needs to be enhanced. The inclusion of these principles would help us to arrive at an explicit model of intonation relating to contemporary north Indian raga performance.

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